

WHO

**SYSCOM:** NAVSEA

**Sponsoring Program:** Naval Ordnance Safety and Security Activity (NOSSA)

**Transition Target:** Naval Facilities Engineering Systems Command (NAVFAC)

**TPOC:** (301) 744-6032

**Other Transition Opportunities:** U.S. Army Corps of Engineers (USACE), Air Force Civil Engineer Center (AFCEC), Department of Defense Explosives Safety Board (DDESB), U.S. Army Technical Center for Explosives Safety (USATCES), Air Force Safety Center (AFSEC), Defense Contractors (e.g., Lockheed Martin, Raytheon, Northrop Grumman, etc.), Magazine Manufacturers (e.g., Armag Corporation, CoverSix, Secureall, etc.)

**Notes:** The graphic above is a three dimensional rendering of a Lightweight Foam Composite (LFC) earth-covered magazine (ECM). The LFC ECM is comprised of modular, prefabricated roof panels that can be lifted by a standard forklift. Karagozian & Case, Inc. (K&C), the developer of the LFC ECM, is a leader in the design of innovative structural designs for the blast and impact load space. Past SBIR efforts have resulted in Phase III awards and the extensive use of the developed technology by the targeting, survivability, and explosives safety arms of the Department of Defense.

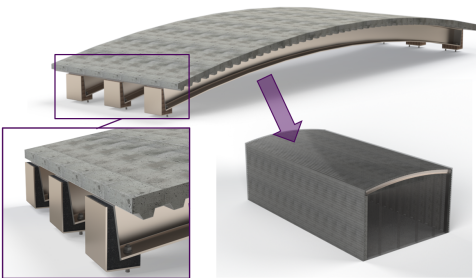


Image courtesy of Karagozian & Case, Inc.

WHAT

**Operational Need and Improvement:** Earth covered-magazines (ECMs) used by the DOD and its contractors to store ammunition and explosives (AE) are scheduled to be replaced in the coming years. Current designs for new ECMs are almost exclusively constructed using reinforced concrete (RC). Although robust and ductile, RC is also heavy (i.e., difficult to lift and ship, and prone to form hazardous fragments in the event of an explosion), susceptible to corrosion and degradation, and reliant on sand, an increasingly scarce commodity.

**Specifications Required:** The Whole Building Design Guide (WBDG) provides a list of approved ECMs for new construction (<https://wbdg.org/building-types/ammunition-explosive-magazines/ecm-approved-new-construction>). Other ECMs must comply with the protective construction requirements defined in Unified Facilities Criteria (UFC) 3-340-02.

**Technology Developed:** The Lightweight Foam Composite (LFC) ECM incorporates lightweight glass fiber reinforced polymer (GFRP) composite and foam materials into modular prefabricated panels. The roof panels in an LFC ECM take the form of a slight arch to leverage the mass of the surrounding earth cover for blast resistance. The LFC ECM constituent components are specifically designed to minimize the number and complexity of connections requiring field installation.

**Warfighter Value:** The LFC ECM offers the potential for enhanced blast energy absorption, reduced secondary fragmentation hazard, expedited construction timeline, and reduced life-cycle cost benefits when compared with existing RC ECM designs. By utilizing lightweight materials, the fragment hazard posed by an LFC ECM is lower than that associated with a RC ECM. The use of modular pre-fabricated constituent components with a minimum amount of welding limits field erection times considerably. Finally, the GFRP and rigid polyurethane foam materials that constitute the bulk of the LFC ECM are stable under the harshest temperature and humidity conditions.

WHEN

**Contract Number:** N68335-22-C-0126

**Ending on:** Dec 08, 2022

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Develop Analytical Model for LFC ECM Concept	N/A	Compliance with allowable strength and deformation performance requirements mandated by explosives safety regulations	2	1st QTR FY21
Quasi-Static Testing of Half-Scale LFC ECM Roof Panels	Low	Verification that analytical model is capable of predicting LFC ECM roof panel response	4	1st QTR FY23
Dynamic Testing of Half-Scale LFC ECM Roof Panels	Medium	Verification that LFC ECM roof panel does not exhibit an unforeseen detrimental response under dynamic loading conditions	6	1st QTR FY24
100% Drawings, Specifications, and Calculations for an LFC ECM	Medium	DDESB approval (pending successful full-scale blast demonstration test)	6	1st QTR FY25
Blast Demonstration Testing on Full-Scale LFC ECM	Medium	Verification that LFC ECM response under design basis explosion protects A/E from sympathetic detonation	8	TBD

HOW

**Projected Business Model:** A primary objective of this work is to have the LFC ECM listed as an approved magazine by the DDESB. It is anticipated that this approval will be provided following full-scale blast demonstration testing. Having this approval will release K&C to promote the LFC ECM as a viable alternative to existing RC ECM designs to the DOD commands responsible for constructing AE facilities (i.e., NAVFAC, USACE, and AFCEC). Promotional efforts would highlight the results of the full-scale blast demonstration testing as well as the benefits inherent in the LFC ECM system (i.e., enhanced blast performance, reduced secondary fragmentation hazard, expedited construction timelines, and minimized life-cycle costs). The LFC ECM would be manufactured by K&C's manufacturing arm, Karagozian and Case Manufacturing (KCM). KCM plans to assemble all of the half-scale and full-scale LFC ECM panels created under the Phase II effort and beyond. KCM will work procure the constituent components of the LFC ECM from its list of suppliers (e.g., Fibergrate, General Plastics) accrued over the course of the SBIR effort.

**Company Objectives:** K&C's mission is to provide state-of-the-art scientific and engineering services to quantify and manage risks, design protective solutions, and develop technology for the construction, defense, manufacturing, space, and energy markets. We do this by quantifying system vulnerabilities to a variety of man-made and natural threats, developing novel and cost-effective engineering designs to mitigate them, formulating and employing state-of-the-art analytic methods and software, and conducting applied research and testing.

**Potential Commercial Applications:** Given Government's restrictions on mass storage of ammunition and explosives, it is expected that direct commercial applications for this technology are limited. With that said, the rate effects testing on GFRP and plastic foam materials conducted as part of this effort could be applied to the innovative solutions to protect people and structures in the event of earthquakes, hurricanes, and terrorism.

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